The aCORN Experiment on NG-C

NCNR Expansion Panel
Scott Dewey

Outline

- Distinct nature of NG-6/NG-C
- Brief introduction to the aCORN experiment
- The schedule for our move from NG-6 to NG-C
- The support needed
- The pit

History of NG-6 Experiments

- Time Reversal Asymmetry (emiT) Testing
- Beam Neutron Lifetime Testing
- Parity Violating Spin Rotation in Helium I
- Time Reversal Asymmetry (emiT) I
- Beam Neutron lifetime I
- Time Reversal Asymmetry(emiT) II
- Radiative Decay of Neutrons (RDK) I
- Parity Violating Spin Rotation in Helium II
- Radiative Decay of Neutrons (RDK) II
- Electron- Antineutron Correlation (aCORN)
- Beam Neutron Lifetime II
- Parity Violating Spin Rotation in Helium III
- Nab

Current and Recent Programs/Experiments

- **Radiative Decay of Neutrons (RDK):** NIST, Tulane University, University of Maryland, University of Michigan, Arizona State University and University of Sussex
- **UCN Lifetime:** NC State, NIST, Harvard and Yale
- **Parity Violating Spin Rotation:** Indiana University, Gettysburg College, George Washington University, University of Washington, NC Central University, NIST, JINR and Kazakh University
- **'a' Correlation in Neutron Decay (aCORN):** Tulane University, NIST, Indiana University, DePAW University, Hamilton College, Harvard and University of Sussex
- **Time Reversal Asymmetry (emiT):** University of North Carolina, NIST, University of Washington, Tulane University, Hamilton College and LBNL
- **Neutron Interferometry:** Tulane University, MIT, NIST, NCSU, NCSU_WIL, Yale and Indiana University
- **Magnetic Dipole Moment:** University of Hawaii, ANL, Valparaiso University, NIST, Indiana University and Tulane University
- **He-3 Polarization:** NIST, Indiana University, Hamilton College and Wisconsin University
- **Absolute Neutron Counting/Beam Lifetime:** NIST and University of Tennessee/ORNL

SUPPORT

NSF, DOE and NIST

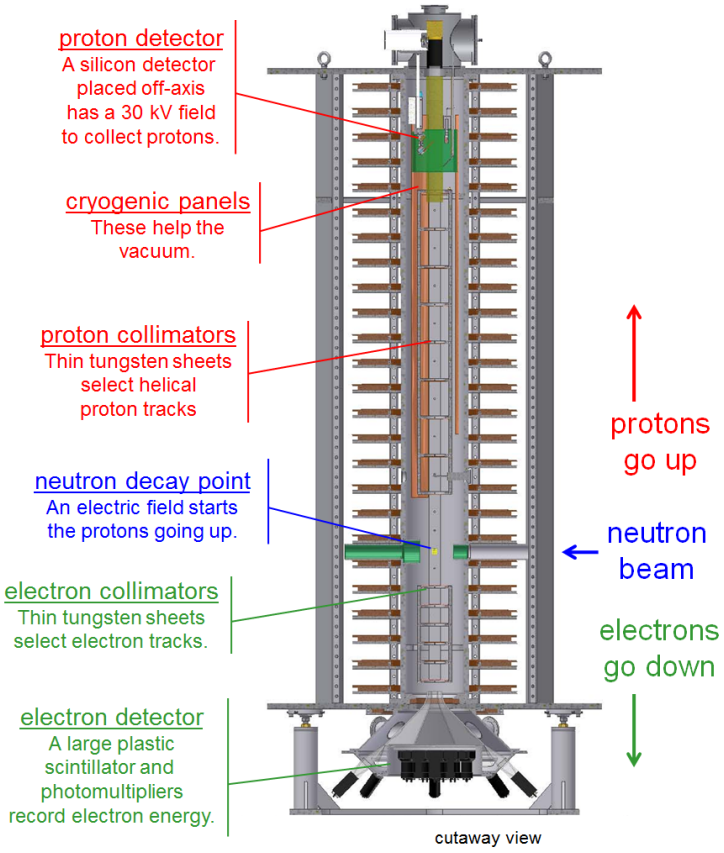
aCORN

Construction funded under an MRI grant from the NSF.

A measurement of the "little a" correlation parameter between the electron and anti-neutrino momenta in neutron beta decay

$$n \rightarrow p e \bar{\nu}_e$$

A 360-G axial B field and internal collimation restrict observed coincidences between electrons and protons to those with momenta close to the vertical axis.



$$\lambda^2 = \frac{1-a}{3a-1}$$

$$g_A = \lambda g_V$$

$$V_{ud}^2 = \frac{4908.7}{\tau_n (1+3g_A^2)}$$

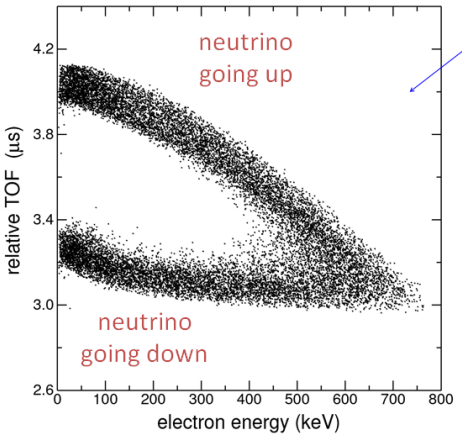
"Little *a*" determines λ and the axial vector coupling, g_A for a weak interaction test.

Together with the neutron lifetime, one can test CKM unitarity (Standard Model).

By selecting neutron decays with protons going up and electrons going down, we keep two kinds of events, those with neutrino directions either up or down. The asymmetry in these two rates measures "little *a*."

$$Rate \propto 1 + a \frac{\vec{p}_e \cdot \vec{p}_{\bar{\nu}}}{E_e E_{\bar{\nu}}} + \ldots$$

Good Wishbone Events



Measuring "little *a*" to 0.5% Improves the world average for λ by a factor of 2.

Ed Stephenson
George Noid
[for IUCF]

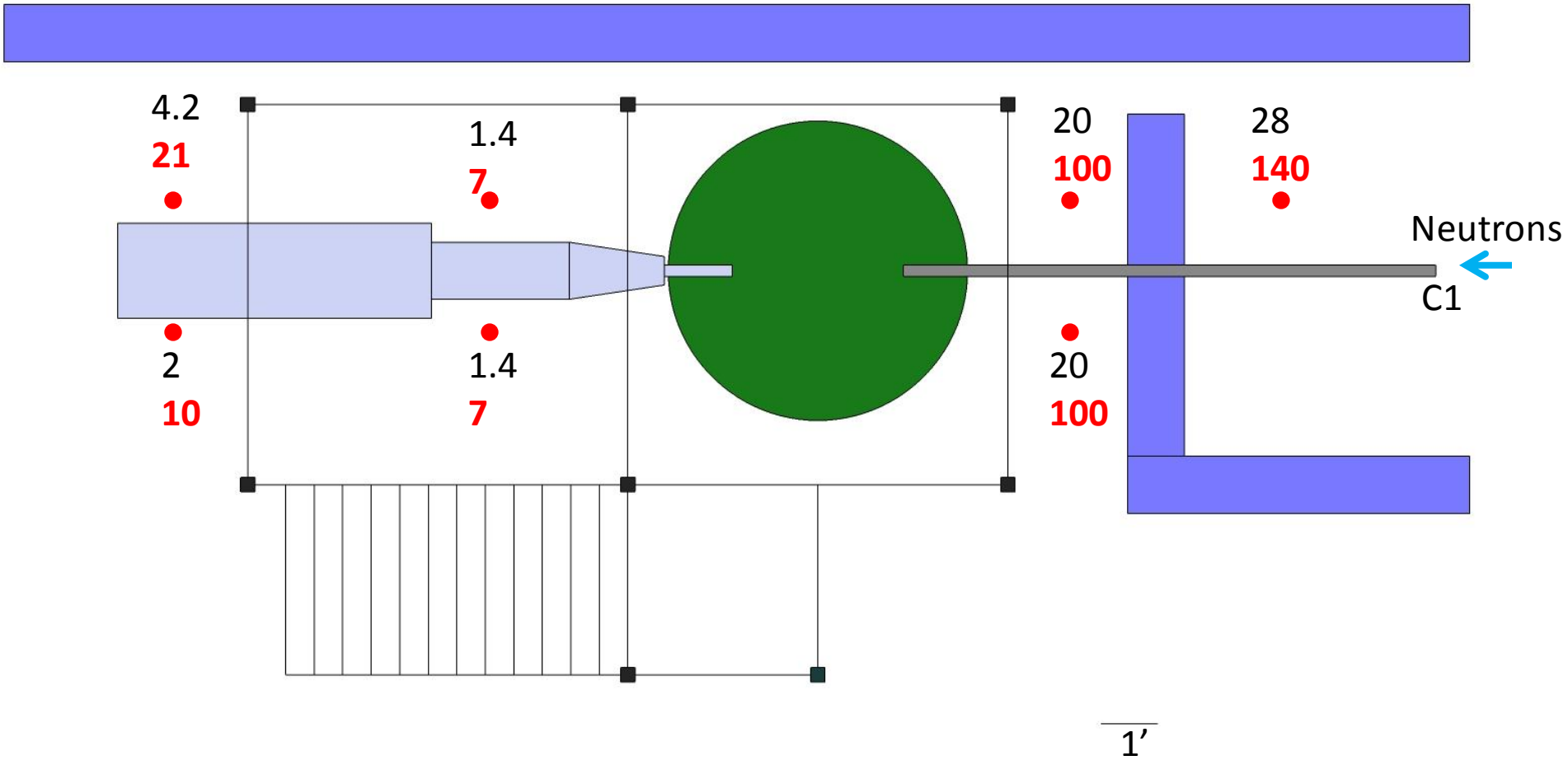
The Move Schedule

- Our goal is a 4% measurement on NG-6
- It appears as though the second quarter of 2013 would be a good time for this move
  - A likely scenario would be: this cycle + two cycles for debugging + four cycles of running
- During the move, it is likely that aCORN will be down for about four months.

The Needed Support

- We and the NCNR technical staff believe that the move from NG-6 to NG-C can be accomplished with the overhead cranes and a fork lift truck. It can probably be done in about two days.
- We have a need for professional engineering support to help design our shielding so that it provides a safe environment and is consistent with NCNR shielding policies and geometries (see the following graphic).

aCORN top view (to scale)

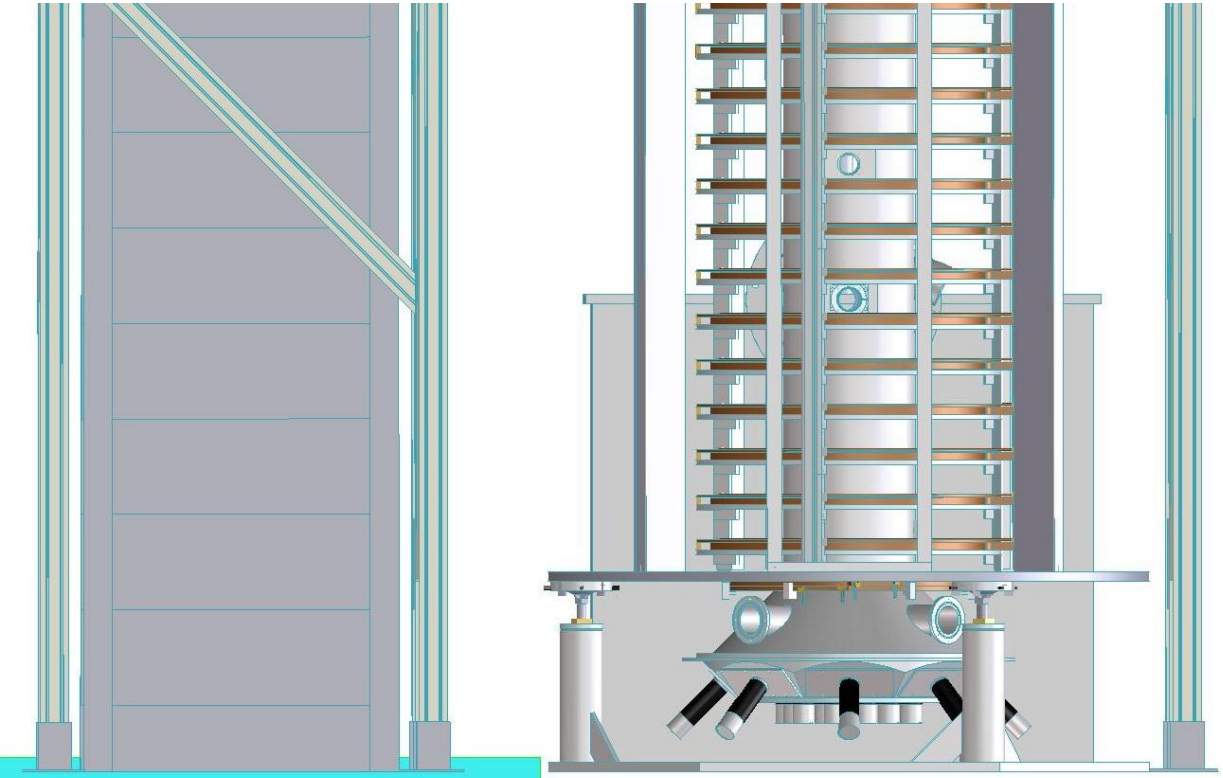


Radiation levels (mRem/hr) at NG-6 (2” collimator at C1) (**no supermirror in place now**)

Radiation levels (mRem/hr) for NG-C beam (5 times more intense)

The Pit

- With aCORN, the clearances are very tight (see following graphic). Given the nature of these experiments, we feel that more contingency is needed. Modifications are commonly made to various systems along the way since these are in no way turnkey experiments.
- This will be the most intense beam line for fundamental physics in the US for the foreseeable future. It should be the best we can make it. aCORN was designed before the guide hall expansion was planned and there was no pit at NG-6. Otherwise it would have been designed differently to take into account the large advantage that a pit provides for this type of experiment.



Clearances when β-detector is lowered:

1.3” to edge of PMT
2.9” to rim on β-detector